Amplification in 2D Photonic Crystals

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Recently, many optical nonlinear functionalities have been demonstrated on two dimensional photonic crystals (2DPC), such as laser operation, wavelength tuning and fast switching [1,2]. In this work we demonstrate for the first time optical amplification in a InP-based 2DPC. We achieve an on/off gain of 27dB at 1.56 μm for a mean pump intensity of 4 KW/cm^2. Since the gain is probed quite far from the electronic band gap (~50 nm far in the Urbach tail), the simple passage gain is low. The key feature to obtain appreciable amplification is then the degree of light confinement into the structure provided by a high Q band-edge photonic resonance. As a consequence, the total gain is increased by a factor equal to the local intensity enhancement in the resonator with respect to the single passage gain. One of the particularities of our system with respect to other 2D geometrical configurations (such as cavities of the defect type), which could achieve the same degree of light confinement, is the possibility of coupling light into the resonator through radiative modes in the normal direction with respect to the periodicity direction. Engineering the finesse of the photonic resonance, as well as its position with respect to the semiconductor band gap, offers a high degree of flexibility in designing optimal amplification parameters for single or broad band amplification, an issue that will be discussed during the talk.

[1] F. Raineri, Crina Cojocaru, P. Monnier, A. Levenson, R. Raj, C. Seassal, X. Letartre, and P. Viktorovitch, "Ultrafast dynamics of the third-order nonlinear response in a two-dimensional InP-based photonic crystal ", Appl. Phys. Lett. **85**, 1880-1882 (2004)
[2] F.Raineri, C.Cojocaru, R. Raj, P.Monnier, C.Seassal, X. Letartre, P. Viktorovitch, A. Levenson, “Tuning a two-dimensional photonic crystal resonance via optical carrier injection”, Opt. Lett. **30**, 64 (2005).